Results: The mean GTV volumes ranged from 149.44 to 526.53 cc. VMAT plans show good results in comparison with 3DCRT in both conformity index (0.81±0.09 Vs 0.68±0.07 respectively, p-value of 0.009), and heterogeneity index (0.11±0.03 Vs 0.14±0.02, p value= 0.042). Furthermore, minimum doses to PTV in VMAT plans are higher than 3DCRT plans (57±1.22 Vs 55.1±0.86, p value= 0.001).
In risk structures, the lung volume receiving 10Gy, 20Gy and 30Gy were reduced in VMAT plans (with relative reduction of 2.27%, p=0.002; 4.87%, p=0.001; 11.8% respectively). Mean lung dose was also reduced (15 Vs 17.69) but not statistically significant. V30 of the heart was reduced compared to 3DCRT (7.53±6.2 10.43±6.8 with p value of 0.051). The maximum dose of esophagus with VMAT was 47.7 Vs 48.69 with 3D CRT (not statistically significant). Moreover, D 50 of the esophagus was less with VMAT (19.94 Vs 23.63) with p value of 0.22.
Regarding monitor units, the mean values were (461.40±124.42 Vs 227.90±13.52) for VMAT and 3D CRT respectively.

Conclusion: Inspite of large PTVs included in our study VMAT planes showed tendency toward reduction of mean and high lung dose and heart doses. Reduction in esophageal doses was not statistically significant , This was obtained without impairment of PTV coverage that was improved in some cases. VMAT for advanced lung cancer can help to improve therapeutic ratio and may open the door for dose escalation

EP-1679

A single centre experience of using helical tomotherapy (HT) for craniospinal irradiation (CSI)

M. Singhera[1], T. Falco[1], K. Blythe[1], R. Begum[1], T. Greener[1], R. Beaney[1], N. Mikhaeel[1]
[1]*Guy's and St Thomas' NHS Foundation Trust and King's Heath Partner's Academic Heath Sciences Centre, Radiotherapy, London, United Kingdom*

Purpose or Objective: CSI is one of the most complex radiotherapy (RT) treatments. Conformal 3D RT techniques require many fields (field within field / segments) to achieve homogeneity and minimise doses to organs at risk (OAR) and involve field junctions. The planning process is time consuming and the actual treatment delivery is long, frequently exceeding 30 minutes. HT offers an excellent alternative with the ability to treat patients in supine position, without junctions and with better dose distribution. The aim of this study is to evaluate the use of HT in CSI with emphasis on dosimetric parameters and treatment duration.

Material and Methods: Retrospective analysis of treatment planning and dosimetric indices was undertaken on seven patients who received cranio-spinal radiotherapy with HT at our centre. The HT plan was delivered using 51 beam angles per rotation, with a constant modulation factor of 2.0, field width of 5 cm and one of two pitches (0.43 or 0.28) to optimise treatment plans. An iterative inverse planning algorithm based on least squares minimization was used which optimises multi-leaf collimator at each beam angle. Dose was calculated by convolution and superposition. Patients were imaged daily covering different areas of the body and corrections applied for directional errors. Data analysis was done using descriptive statistics.

Results: Helical tomotherapy plans for seven adult patients were analysed. Five patients had a haematological malignancy and two had a medulloblastoma. Five patients with a haematological diagnosis received a dose of 30Gy in 1.5Gy/#. Two patients with medulloblastoma received 35 Gy delivered in 1.67Gy/#. Details of treatment planning and plan evaluation parameters of seven patients are presented in Table 1.

Patients	1	2	3	4	5	6	7	Average
Pitch	0.4	0.4	0.2	0.2	0.2	0.4	0.4	
Modulation factor	2	2	2	2	2	2	2	
Dose/dose per # (Gy)	30/1.5	30/1.5	30/1.5	30/1.5	30/1.5	35/1.67	35/1.67	
PTV volume (cm^3)	3701.1	2875.3	3505.9	2941.9	3508.9	3623.8	3455.8	3373.3±328.9
Dmax PTV	32.3	31.5	31.8	31.8	31.7	37.8	37.6	
Dmin PTV	18.9	20.2	25.9	23.1	20.3	20.4	21.4	
Mean dose to R lens	18.7	10.8	16.2	27.4	9.6	4.1	4.2	13.0±8.3
Mean dose to L lens	16.2	16.9	17.5	26.8	7.7	3.8	4.6	13.4±8.3
Mean dose to spleen	7.6	5.5	5.2	5.4	6.1	6.5	6.4	6.1±0.8
Mean dose to thyroid	17.3	23.6	16.4	20.7	10.6	21.8	17.8	18.3±4.2
Mean dose to lung	10.3	11.6	8.8	8.1	9.2	4.4	8.1	8.6±2.2
V_5	71.1	80	67.4	84.9	64.9	43.1	78	
V_{10}	51.0	58.4	44.2	34.6	46	23	30	
V_{20}	13.1	18.6	13.1	10.1	12.2	5.2	5.1	
Mean dose to heart	10.1	9.9	8.7	12.2	9.4	12	8.8	10.9±1.3
V_5	99.9	99.3	99.3	99.8	99.1	99.4	100	
V_{10}	51.1	47.9	33.4	77.2	40.6	74.4	33.2	
V_{20}	0.47	1.4	0.0	1.3	0.0	5.9	0.0	
Mean dose to kidney	8.1	10.7	10.5	10.4	11.0	9.8	8.6	9.9±1.09
V_{15}	16.9	21.2	21.5	24.8	21.3	6.3	6.4	
Mean dose to liver	8.4	11.1	9.6	11.6	10.4	8.6	8.7	9.8±1.2
Mean dose to bladder	5.9	4.0	1.1	0.7	6.4	7.0	2.6	3.9±2.5
Beam 'on-time' (minutes)	9.5	9.3	8.6	10.2	11.9	11.6	11.6	10.3±1.3

PTV: Planning target volume, DmaxPTV: Maximum dose to PTV, Dmin: Minimum dose to PTV

Overall HT plans achieved excellent PTV coverage with mean V95 of 33.5 Gy for medullblastoma patients. The mean V95 was 28.3 Gy for those with a haematological diagnosis. The mean homogeneity index was 1.0. Organs at risk doses were well below tolerances required. In particular averaged mean heart dose was 10.9±1.3, mean lung dose was 8.6±2.2 and mean liver dose was 9.8±1.2. The mean D50% for lung was 7.2 Gy±3.8 and mean D10% was 20.2Gy±3.6. The mean D50% for the heart was 10.1Gy±1.3 and mean D10% was 14.7Gy±2.1.

Conclusion: HT for CSI has many advantages including: the ability to treat patients in supine position, no need for junctions, excellent PTV coverage, low doses to OAR and shorter treatment time.

EP-1680

Treatment planning of stereotactic radiosurgery for single brain metastases: impact of leaf width

E. Lamers-Kuijper[1], E. Van der Bijl[1], A. Van Mourik[1], C. Van Vliet-Vroegindeweij[1], E. Damen[1]
[1]*The Netherlands Cancer Institute, Department of Radiation Oncology, Amsterdam, The Netherlands*

Purpose or Objective: Stereotactic radiosurgery of brain metastases requires highly conformal dose distributions. Besides beams setup, characteristics of the linear accelerator collimator may also play a role. In this study we compared the impact of leaf width on the dose outside the target for stereotactic radiosurgery of single brain metastases.

Material and Methods: For 10 patients with one lesion, treatment plans were generated using two MLC types: Elekta Agilty with 0.5cm leaf width and Elekta MLCi2 with 1cm leaf width. Two VMAT arcs were used, one coplanar arc and one non-coplanar arc (couch 90°). Five patients had a PTV volume ≤ 4 cm^3 with a prescription dose of 24Gy in 1 fraction, and 5 patients had a PTV volume between 4 and 14 cm^3 with a prescription dose of 18Gy in 1 fraction. All plans were required to fulfill clinical requirements: V100%Dpres>95%VPTV, D0<150%Dpres and OAR doses as low as possible and never above clinical constraints. The maximum dose in the PTV is kept the same per patient in both plans. The quality of the dose distribution outside the PTV was evaluated using the mean dose in two ring structures, adjacent to the PTV.

Results: The mean dose was evaluated in the first 2 rings of 5 mm around the PTV(table 1). The difference in mean dose for the small lesions(Dpres=24 Gy) of the first ring of 5 mm is 1.8 Gy in favor of the Agility and 0.9 Gy for the larger lesions(Dpres=18 Gy)also in favor of the Agility. The difference is smaller for the larger lesions (figure1). Also for the second ring of 5 mm, adjacent to the first ring, the difference is is 1.1 Gy vs 0.8 Gy also in favor of the Agility.

	24Gy							18Gy						
	Ring5mm(Gy)			Ring10-5mm(Gy)				Ring5mm(Gy)			Ring10-5mm(Gy)		
Patient	MLCi1	Agility	Diff	MLCi1	Agility	Diff	Patient	MLCi1	Agility	Diff	MLCi1	Agility	Diff
1	12.2	10	2.2	5.6	4.6	1	6	12.4	10.9	1.5	5.5	4.7	0.8
2	12.9	10.9	2	6.3	5.3	1	7	14.6	13.8	0.8	4.5	3.8	0.7
3	11.9	10.4	1.5	5.6	4.8	0.8	8	13.5	12.3	1.2	7.6	6.2	1.4
4	19.9	17.9	2	5.4	4	1.4	9	14.5	13.8	0.7	5.2	4.6	0.6
5	16.5	15.1	1.4	8.4	7.1	1.2	10	13.3	12.9	0.4	7.2	6.7	0.5
mean	14.2	12.9	**1.8**	6.2	5.2	**1.1**	mean	13.7	12.7	**0.9**	6	5.2	**0.8**
SD	3.5	3.5	**0.3**	1.2	1.2	**0.2**	SD	0.9	1.2	**0.4**	1.3	1.2	**0.4**

Tabel 1: Mean dose in the rings around the PTV at 5 mm and 10 mm for small lesions (PTV volume < 4 cm³) and the larger lesion (PTV volume between 4 and 14 cm³)

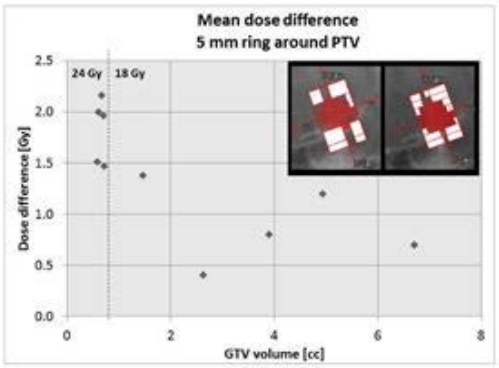


Figure 1: The mean dose difference in the first 5 mm ring around PTV. In the right upper corner the typical leaf setting for the Agility on the right and the MLCi1 on the left.

Conclusion: For the small lesions with a volume smaller than 4 cm³ the Agility shows a steeper gradient in the two surrounding rings than the MLCi1. Therefore we recommend the use of the Agility for treating the smaller lesions.

EP-1681

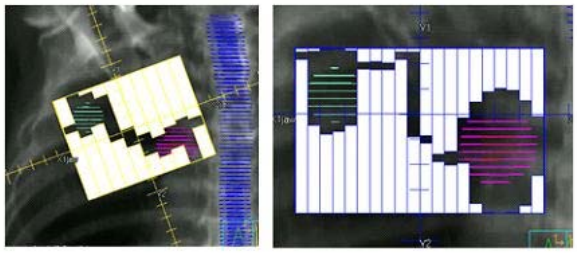
A treatment planning strategy for SBRT of multiple T1-2 lung tumors

A. Tijhuis[1], E. Van der Bijl[1], J. Knegjens[1], C. Van Vliet-Vroegindeweij[1], E. Damen[1]
[1]*The Netherlands Cancer Institute, Department of Radiation Oncology, Amsterdam, The Netherlands*

Purpose or Objective: To obtain a planning technique for SBRT treatment of multiple lung tumors, which is suitable for all relative positions of the tumors.

Material and Methods: For 10 patients with two tumors, treated with 3 x 18Gy, VMAT plans were generated in Pinnacle, using various approaches: simultaneous versus sequential optimization, with or without the dose distribution of one tumor as background for optimization of the other tumor. The quality of the treatment plans was judged on coverage (PTV V100% >95%), conformity (V100%/PTV volume), inhomogeneity (PTV D0<165%) and dose constraints on OARs.

Results: Simple addition of beams for two independently planned tumors does not yield optimal results since the mutual low dose contributions cannot be taken into account properly. Simultaneous optimization on both targets results in pairs of open leafs in-between the lesions (Fig 1). We therefore concluded that the strategy that yields the most conformal plans is the subsequent planning of the tumors using a dual-arc for both, where the dose distribution resulting from the planning of the first target is used as a background dose while optimizing the beams for the second target. During optimization of the first tumor, no limit is applied for the dose to the second PTV, since this can be compensated for in the optimization procedure for this PTV. After optimization of the second PTV, the number of monitor units in each beam pair might be adjusted slightly to conform to the required target coverage. This strategy works for two or more isocenters as well as for one mutual isocenter. For three or more tumors, iterating the above method yields good results



Two examples of simultaneous optimizing on both targets (fig1)

Conclusion: We developed a generic planning strategy to obtain high quality lung SBRT-treatment plans for patients with multiple lung tumors. The strategy uses a dual-arc VMAT for each tumor, while taking the dose distribution covering the first target is used as background during dose optimization for the second target. This method is clinically in use since March 2015, since then 15 patients have been treated using this method.

EP-1682

Breast and regional lymph nodes RT: V-MAT/RapidArc and Tomotherapy comparison

M. Valli[1], L. Negretti[2], S. Cima[1], M. Frapolli[1], A. Polico[1], G. Nicolini[3], E. Vanetti[3], A. Clivio[3], A. Richetti[1], G. Pesce[1], F. Martucci[1], C. Azinwi[1], K. Yordanov[1], S. Presilla[3]
[1]*Oncology Institute of Southern Switzerland, Radiation Oncology, Bellinzona-lugano, Switzerland*
[2]*Clinica Luganese, Radiation Oncology, Lugano, Switzerland*
[3]*Ente Ospedaliero Cantonale, Medical Physics Unit, Bellinzona, Switzerland*

Purpose or Objective: Two centers compared VMAT/RapidArc (RA) and Tomotherapy (TOMO). for the irradiation of breast and regional lymph nodes.

Material and Methods: Five left and five right breasts plus regional nodes have been contoured by two dedicated radiation oncologists. Two senior physicists checked the treatment plans studied by dedicated dosimetrists. The Anatom-e tool was tested for improving definition and avoiding interpersonal variability in the contouring. Prescription, according to ICRU, was 50 Gy in 25 daily fractions. We considered both lungs, the heart, the left anterior descending coronary artery (LAD), the controlateral breast and the thyroid as Organa t Risk (OaR). The dose constraints were: PTV V95=95%, ipsilateral lung V20 20%, heart mean dose < 10Gy, heart max dose <35Gy, LAD max dose ≤20Gy, thyroid max dose < 45 Gy and contralateral breast max dose≤5 Gy. We have studied the treatments in free breathing modality, perfectly aware of the higher dose received by heart and LAD in comparison to the respiratory-gated modality, routinely used in the RA center.

Results: We summarized the results of this comparison in Table 1

Table 1. Left and right breast plus lymphnodes.

	TOMO	RA
LEFT BREAST + LN	% (±SD)	% (±SD)
V95% PTV	94.9 (±0.5)	95.1 (±10)
V20Gyipsilateral lung	15.9 (±1.3)	22.2 (±3.2)
	Median dose Gy (±SD)	Median dose Gy (±SD)
LAD	4.7 (±0.9)	15.7 (±4.5)
Heart	3.5 (±3.8)	9.0 (±1.7)
Contralateral breast	5.1 (±1.4)	4.2 (±1.1)
	Median min (±SD)	Median min (±SD)
Beam-on time	6.91min (±0.21)	1.03min (±0.03)
RIGHT BREAST + LN	% (±SD)	% (±SD)
V95 PTV	95.0 (±0.5)	94.9 (±0.1)
V20 ipsilateral lung	19.4%(±3.1)	21.2%(±1.5)
	Median dose Gy (±SD)	Median dose Gy (±SD)
LAD	2.0 Gy (±1.1)	7.7 Gy (±0.9)
Heart	5.9 Gy (±0.8)	6.8 Gy (±1.5)
Contralateral breast	3.6 Gy ± (0.5)	4.2 Gy (±0.4)
	Median min (±SD)	Median min (±SD)
Beam-on time	5.9min (±0.26)	1.07min (±0.01)

Conclusion: Both techniques allow a good coverage and dose uniformity for the PTV, with proper sparing of the OaR. TOMO